ABSTRACT

Title of Thesis: *<u>Reasons and Rationalizations for Bedtime Procrastination in University Students</u>*

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University students are often known for their poor sleeping habits, which have ill-effects on various aspects of their lives. However, causes for this lack of proper sleep are underexplored. In this thesis, I focus on understanding reasons and rationalizations for delaying one's bedtime when there are no direct external circumstances preventing a person from doing so. I investigate what types of activities students engage in before bedtime, their own reflections on these activities, and their sleep the following night. To this end, I completed a two-week survey and debriefing interview to uncover reasons and rationales for bedtime procrastination. I conclude that screen-time, attention-maintaining activities, and social expectations are key factors in delaying one's bedtime, and that minimal effort assigned to self-tracking and reflection may enable better sleeping habits, which were found desirable by all participants.

REASONS AND RATIONALIZATIONS FOR BEDTIME PROCRASINATION

by

Matthew David Patrick

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Dedication

To my parents, sister, and rescue dog, Raj, who continue to support and love me through all my life's endeavors.

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Finally, thank you to all the participants who gave their time, shared experiences, and detailed reflections for this research. This research would not have been possible without you, and I hope your desires to improve your sleep remain vigilant for many years to come.

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Chapter 1: Introduction

Bedtime procrastination is defined by Kroese et al. as the “phenomenon of postponing going to bed, typically resulting in a lack of sleep” (Kroese et al., 2016), and by Keulen as “failing to go to bed in time, while no external circumstances prevent a person from doing so” (Keulen, 2020). Most of us can think of instances where we have slept later than we had wanted, and subsequentially regretted it the next day or week. This bedtime delay has become especially prevalent in recent decades due to the rise of more easily accessible technology, internet, and its usage, especially around bedtime. In fact, Americans sleep on average 6.8 hours per night, which is a full hour less than they did 70 years ago (Gallup, 2013). Also, 40% of Americans are getting 6 hours or less sleep per night, which is well below the recommended number of hours of sleep per night (Kroese et al., 2016). Lack of sleep is something we can relate to at some point in our lives, and often it corresponds to negative effects.

However, many people are unaware to the degree of which bedtime procrastination is occurring and/or affecting them. Health screenings often include questions heavily weighted towards diet and exercise as compared to sleep (Sorscher, 2008), which often leads to sleep-related health being overlooked in many cases. One study of 163 Amazon Mechanical Turk participants found that when prompted about ways they could improve their health, a large majority of participants spontaneously mentioned exercise (86%) or diet (84%), but only a small minority mentioned sleep (12%) (Nauts & Kroese, 2014). Failing to put sleep-related health alongside other health factors can increase delayed sleep from a lack of time-awareness, heightened anxiety, decreased regulatory resources to decide to go to bed, or other unknown causes (Kroese et al., 2016). Often these exact reasons for doing so are unconscious or overlooked by the individual, but this delay in sleep can disturb one's circadian rhythm, and ultimately leads to short-term and long-term sleep deficits. This failure to maintain consistent sleeping times may be detrimental to health, as consistent sleep is foundational to improving and maintaining diet, exercise, and many other lifestyle aspects, and should be at the forefront of those aiming to live healthy lives.

Research has also consistently shown that sleep deprivation is rampant and cause of great concern across many societies and communities. A 1996 meta-analysis of sleep deprivation with 1,932 total participants found that overall sleep deprivation strongly impairs human functioning, and that these effects of sleep deprivation were likely underestimated by the participants when reflected upon (Pilcher & Huffcutt, 1996). More recently, sleep deprivation has been a growing health concern in contemporary society, with new research showing even more detrimental effects of lack of sleep: short sleep durations were found to be associated with increased cardiovascular disease risk and atherosclerotic plaque development (Cherubini et al., 2021). Another recent study on sleep deprivation in medical students unveiled that those reporting more sleep deprivation showed significantly greater odds ratios of presenting anxiety and depression symptoms and lower odds of good quality of life or perception of educational environment (Perotta et al., 2021). These studies indicate that sleep deprivation is an ongoing and increasingly worrying concern.

This thesis focuses on identifying reasons and rationalizations for why people, in particular university students, choose to engage in bedtime procrastination. Bedtime procrastination can occur consciously or unconsciously, and in varying contexts given student schedules, goals, and lifestyle. This makes it especially difficult to pinpoint one or two specific contributing factors, as many likely exist in tandem. Additionally, this thesis aims to enable students to be able to be aware of, understand, reflect, and alter their behaviors surrounding sleep hygiene and routines, with the goal of improving sleep quality, quantity, and overall life improvements. It is motivated by the idea that spending some level of effort on improving one's sleep will provide a large amount of benefit in other aspects of their life. Determining how students view sleep and their own habits both in and out of study is key when investigating how to improve upon them. While this thesis is exploratory in nature, I start by identifying some research questions to investigate these concerns:

RQ1: What reasons and rationalizations lead to bedtime procrastination in University students?

RQ2: How does self-tracking and reflection of near-bedtime activities affect students' awareness of sleep hygiene and desire to improve them?

To answer the questions above, I conducted a 2-week sleep study which had daily morning surveys to be completed right after waking. These surveys included questions regarding sleep quality and quantity, reflection on their sleep, and most importantly, an activity matrix that chronologically listed all activities the participant had engaged in approximately 2 hours before sleeping. Participants were also asked to give detailed contextual information for each activity. After the 2-week survey, I conducted debriefing interviews to delve deeper into participants' reasons for any bedtime procrastination with surrounding context, and how the reflection questions affected the participants overall. I then conducted an affinity analysis on all activity matrices to determine what types of activities participants were doing and why they were doing them, and an inductive thematic analysis on the interviews to find common themes for rationalizations for bedtime procrastination. I find both qualitative and quantitative analyses helped in my understanding of students' sleeping habits.

My thesis is structured as follows. Chapter 2 details the related work surrounding bedtime procrastination, sleep, and self-tracking and reflection to understand what the current landscape is like. Chapter 3 presents the methodology of my study and breaks down into parts the ways I decided to investigate these questions. Chapter 4 depicts the findings of the study and interviews, including generalized descriptive statistics, bedtime procrastination themes, and participants' feelings towards further sleep habit improvement. Chapter 5 discusses the findings in regard to the research questions, as well as limitations and future research avenues for this work. Finally, Chapter 6 discusses the conclusions made from this study.

Chapter 2: Related Work

2.1 The Bedtime Procrastination Landscape

When considering lifestyle changes to improve one's health, sleep is often overshadowed by other domains such as diet and exercise. Kroese et al. emphasizes this: "*Public health campaigns directed at raising awareness about the risks of alcohol use, obesity, and smoking are ubiquitous, with public service announcements, billboards, flyers, and other promotional materials emphasizing the importance of exercise, smoking cessation, and a healthy diet. In contrast, public health campaigns aimed at promoting sleep in the general population are virtually nonexistent*" (Kroese et al., 2016). While sleep behavior as a whole may not be at the forefront of an average person's mind, procrastination in and of itself is a concept familiar to many. But remarkably, procrastination in the domain of health behavior, and subsequently sleep behavior, has received little attention compared to medically diagnosed sleep disorders, such as insomnia (Kroese et al., 2016). The lack of attention towards behavior changes for better sleep is real, however the recent and prevailing work indicates that bedtime procrastination is a domain certainly worth giving such attention. A representative sample of 2,431 Dutch adults found that over 50% of participants, excluding those with a sleeping disorder or who work night shifts, reported going to bed later than they intended (Kroese et al., 2016). Another cross-lagged analysis of 1,181 Chinese college students found significant bidirectional relationships of mobile phone use with bedtime procrastination and depressive symptoms (Cui et al., 2021). Also, a study with a random sample of 821 adults participated in face-to-face interviews and standard questionnaires found that self-regulatory failure over television viewing could partly explain the struggle with bedtime (Exelmans & Bulck, 2017). These findings are problematic given that delayed bedtimes interfere with sleep quality and quantity, and it is widely known that poor sleep leads to a myriad of other detrimental health effects. Sleeplessness accounts for impaired perception, difficulties in keeping concentration, vision disturbances, slower reactions, poor memorizing, schematic thinking (which yields wrong decisions), and emotional disturbances such as deteriorated interpersonal responses and increased aggressiveness (Orzeł-Gryglewska, 2010).

Many of these recent studies find that when individuals engage in bedtime procrastination, it negatively affects their sleep health and consequently other aspects of their life. However, in many cases, they struggle to identify *how* one is consciously or unconsciously rationalizing bedtime procrastination, and whether the context in which procrastinating activities plays an effect. This study aims to fill this gap, specifically in the domain of college students, where many young adults are entering a new chapter of their life where they often have the most control they have ever had before and begin to shape their lifestyle choices, including sleeping behaviors. Our goal in this study is to identify how and to what degree students are engaging in bedtime procrastination. Identifying these reasons and rationales for bedtime procrastination early in one's adult life is crucial to helping promote healthy lifestyle habits before they are much harder to change later in their life.

2.2 Screen Time in Adolescents

The rise of technology has been fairly recent when compared to all of human history, and only a small subset of humanity has been born after before the inception of the internet. Many adults today grew up without access to any internet at all. Internet usage and accessibility have also increased immensely over recent decades. While only 41.5% of households in the United States had access to the internet in 2000, that figure increased to 76.7% by 2014 (File & Ryan, 2014). Today, 93% of American adults use the internet (Pew Research Center, 2021). This internet and screen usage can be prominent in the hours before bedtime – browsing the internet, engrossing oneself in social media, watching Netflix, and many more digital activities. Additionally, children have a surprising amount of accessibility to screens and consequently screen usage. One study found that British children by the age of 10 years have regular access to an average of five different screens at home (Sigman, 2012). Another found that, excluding any viewing time outside the home, such as hand-held screen activities, the average screen time in the home for young British adolescents is 6.1 hours per day, for Canadian children 7.8 hours per day, and for American children 7.5 hours per day – all of which are rising significantly (Leatherdale & Ahmed, 2011). This sort of indoctrination to screens early in one's life can create a culture of screen-viewing later in life. Especially given that children spend a majority of daylight hours in school, this in-the-household screentime certainly bleeds into the night. Left unchecked, many of these habits may manifest themselves into permanent fixtures in a young adult's life (McDade et al., 2012). These findings are a key motivator for choosing my participants' demographic: university students. This is a time where these individuals have more control over their life and can start setting healthier sleep habits. While screen time is expected to be a prominent adversary in delaying one's bedtime, there are other indirect concerns to be addressed with that of being a student in a new environment as well.

2.3 Student Sleeping Concerns

Undergraduate students are particularly at-risk for developing poor sleeping habits throughout their initial years in college. Many of these students are leaving their parents' or guardians' household for the first time in an extended period and are generally no longer subject to the rules of the household, or even just their old household habits. But these pre-set rules and/or habits are often useful, whether consciously or unconsciously, to students. One study showed that compared to high-school adolescents without parent-set bedtimes, those with parent-set bedtimes had earlier bedtimes, obtained more sleep, and experienced improved daytime wakefulness and less fatigue (Short et al., 2011). Many students, directly or indirectly, rely on this routine that is not under their control to maintain good sleep hygiene. When taken away, and without self-set proper sleep routines, students may sleep less and experience negative consequences elsewhere in their life. An in situ weeklong diary study of 76 students showed that students with less-than-ideal sleep reported higher perceived work pressure and productivity, shorter focus duration, higher negative mood, and increased Facebook usage (Mark et al., 2016). Additionally, studies have shown previously that age is a factor in the prevalence of poor sleep quality, specifically that younger adults tend to get poorer sleep (Ma et al., 2019). These factors in combination with busy college academics and social environments make it especially challenging for students to put sleep as a priority, and makes this demographic a prime choice to try and identify and improve upon sleeping problems.

Additionally, students entering college face an overwhelming array of new social scenarios and can feel pressured to keep up. Studies have shown college to not only be academically stressful, but socially as well (Grace, 1997). Fast-forwarding to the present day, where socializing pressure is still high but accessible at the press of a button, students now have to maintain numerous and complex relationships both in-person and electronically to maintain the status quo. When tackling many courses, proper diet, exercise, and other daytime activities, it may become difficult to find time to catch up on the latest social media posts, group chats, and more. Surprisingly, research is thin on how often students are engaging in electronic socializing, and even screen usage in general, during the nighttime hours. This thesis helps fill this gap by addressing these concerns and to what degree students feel about maintaining social interactions at the expense of sleep, in addition to their rationalizations for doing so.

2.4 Self-Tracking and Reflection

When one's goal is to alter their behaviors and lifestyle, many agree that self-tracking one's data is paramount. However, simply self-tracking one's data is often not enough to enact a substantial and consistent change in their life. Most tools that enable self-tracking do not explicitly design for reflection, carrying an implicit assumption that providing access to self-tracking data is sufficient (Kocielnik et al., 2018). One study found that even participants with extensive data tracking experience did not have much experience with reflection beyond checking real-time feedback (Choe et al., 2017). While self-tracking personal data is a great first step in attempting to improve one's behaviors, exponential benefit can be obtained by engaging in deep reflection about such data. Reflecting about certain aspects of one's life provides valuable insights, which in turn lead individuals to reconsider and possibly change particular attitudes or behaviors (Ploderer et al., 2014). Ploderer goes on to describe how *reflection-in-action*, where reflection is done in the moment, and *reflection-on-action*, where reflection is done after an activity has ended, are both crucial components in helping enable change in an individual. This study takes principles from each of these ideas to design survey and interviews questions that foster both types of reflection, to maximize insight gained as researchers, with a byproduct of potential change for the individual in the future. While it is important to not only self-track data and reflect on it, it is also crucial to note that there is such a thing as "over-tracking." One study in understanding practices on exploring personal data found that tracking too many things often led users to either stop tracking entirely due to tracking fatigue or failing to do data analysis due to too much data in different formats (Choe et al., 2014). We take into account these considerations when designing our data capture and visualizations for participants, with a goal of optimizing how much time and effort is spent to perform data capture and isolating the most important visualizations for the user to view post-study.

2.5 Summary

Kroese et al. was one of the first papers that inspired this research, noting that "*research on bedtime procrastination is still in its infancy*" (Kroese et al. 2016). Plenty of research has been conducted on various aspects surrounding sleep deprivation, but not the causes and context from participants to substantiate it, especially regarding bedtime procrastination. Kroese et. al even strongly advocates paying more attention to sleep as a health behavior, and that research is needed exploring people's reasons for engaging in bedtime procrastination – one of the cruxes of this thesis. Human behavior can always be altered, however it is much easier to create healthy lifestyle habits earlier in one's life, when the brain is still developing. With the understanding that children, adolescents, and young adults are increasingly using social media, watching videos, and other screen-time activities more than ever before, it creates a sense of urgency of how to have these activities placed in one's life properly as to not interfere with restful sleep. Targeting a population that is now independent often for the first time in their lives is crucial and has potential for greater benefit to the individual to structure their habits earlier in their life, and maintain them as they venture into adulthood. Successful reflection and action taken towards sleep health improvement also provides a framework for individuals to improve other aspects of their life – such as diet and exercise – as many of the principles of self-tracking and reflection can be utilized in other domains. I aimed to not only discover insights and improve this aspect of others' health, but also to inspire them with the tools necessary to continuously improve all areas of their lives.

Chapter 3: Research Design

3.1 Background

With the knowledge of the current bedtime procrastination research landscape, and the gaps present within, I am motivated to design this study, comprising pre-study briefing, 14-day survey, and post-study interview, to understand underlying reasons and rationalizations more deeply for bedtime procrastination. Oftentimes, these reasons can be unconscious in an individual, which motivates asking self-reflection questions and probing answers comprehensively in post-survey interviews. Additionally, having participants methodically list out activities they had engaged in the previous night helps better investigate what specific factors may exist in propagating this procrastination. Simply asking an individual what they had done the previous night might often yield forgetfulness, or lack of richness in the context surrounding the activity. By having a full detailed activity matrix, I am able to capture this more effectively. However, I am careful to only ask for context that we found to be related to our questions, as to not inundate individuals with too much effort or time with completing the study, which might lead to less adherence or depth of context. This was accomplished through careful pilot studies and iterations to the questions in both the surveys and interviews to minimize effort for the participant while maximizing depth and richness of the responses. The methods in which I enabled capturing such data is as follows.

3.2 Study Procedures

University of Maryland students were recruited for this study via social media advertisements (Facebook, Instagram, and Twitter). Matthew Patrick's social media accounts were used to post recruitment material. To be eligible for this study, participants must have been University of Maryland students 18 years of age or older (part-time or full-time) and must not have a medically diagnosed sleep disorder. Participants were asked to self-report their age and medical sleep diagnoses in the screening questionnaire, which was sent to them after they contacted Matthew Patrick via the recruitment advertisement.

After advertising the study, initially 30 participants reached out and consented to a pre-study briefing. 28 of these participants were deemed eligible for the study, and were officially enrolled in the study. An informed consent form was delivered to eligible participants via email, and only when all 28 forms were signed and returned was the study conducted in full. Adherence was very good – with 25 of the 28 participants having completed all study requirements. The 3 other participants were dropped from the study due to lack of adherence to the study requirements. Each of these remaining 25 participants had completed the survey each day and in great detail. The ages of these participants ranged from 18 to 23 years old with an average age of 20.18 years (SD = 1.18 years). The number of semesters completed at the University of Maryland, College Park ranged from 2 to 9 semesters, with an average of 4.59 semesters (SD = 1.97 semesters).

This study was completely entirely remotely over during a summer academic term (June 2021). First, participants completed a one-on-one pre-study briefing of approximately 15 minutes using the video-conferencing service Zoom. The pre-study briefing included questions to re-confirm eligibility and informed the participant of how the study would be conducted.

Second, participants completed the daily survey portion of the study through the web-based survey tool Qualtrics. This occurred over a period of two weeks, with all participants starting and completing the study on the same days. The daily surveys were completed by participants in the morning and were based on their previous evening activities related to sleeping habits and bedtime procrastination. For each activity listed participants were asked to include the activity name, start time, end time, description, technology involved, rationale for doing the activity, whether the activity was mandatory or self-imposed, and how important it was the activity be completed at this time. Additionally, sleep data was collected from each participant, through self-reporting. The data collected was intended bedtime, actual bedtime, wake time, and sleep duration. These surveys took approximately 5-10 minutes to complete each, and participants entered information regarding their sleep and activities near bedtime in detail. Participants were reminded to fill out the survey in the morning each day through a notification text message. The daily surveys were completed over a period of two weeks for a total of 14 survey responses collected per participant.

Lastly, participants completed a post-study one-on-one interview of approximately 30 minutes after the daily surveys were completed, also using Zoom. The post-study interview asked questions about the aggregate data discovered during the study in addition to self-reflection questions regarding this data. The post-study interview was audio recorded and transcribed.

All data collected from participants was not publicly available and was recorded in a manner that only links it to a separate identifier, to maintain the privacy of the participant. Any participant who was deemed ineligible had their data, including personal data, immediately destroyed. Upon successful completion of all study requirements, participants received a $25 Amazon gift card for compensation for their time.

3.3 Data Analysis

First, general descriptive statistics were generated to gain an overall idea of the participants' sleep goals and behaviors, such as to-bed and wake-up times. Then, the *activity matrix* of each participant was examined in detail. The activity matrix for each participant is a chronological collection of participants' activities collected within 2 hours of bedtime each day. Since this was completed first thing in the morning the following day, participants were generally able to recall in detail what they had done the previous night (and indicated so as well in the interviews). I conducted an affinity analysis of the activity matrix to group similar activities into buckets – for example:

social media use, video games, in-person socializing, hygiene activities, etc. This was compared in conjunction with the computed sleep latencies of each night of each participant to gain an idea of what types of activities might be inducing increased sleep latency. After this, a thematic analysis was performed on the interviews from participants. I referenced and similarly followed a six-step thematic analysis process listed below (Braun and Clarke, 2006):

1. Familiarizing yourself with your data
2. Generating initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Producing the report

Most interviews were between 25 and 30 minutes, and were transcribed manually, with the help of Otter.ai's transcription services. The thematic analysis was performed by first coding the first half of participant's transcripts, and then codes were merged to better identify possible themes emerging within the data. Codes were merged on the basis of how similar the corresponding participant quotation were – generally if two quotations with similar codes were at least 80% similar in the concept they were describing, those two codes were merged. After this analysis, I reviewed all the transcripts multiple times to re-code them, and began developing themes with reference to the qualitative data obtained previously, as well as separate qualitative findings.

From this analysis I was able to more clearly understand why many participants were sleeping later than intended on multiple occasions.

3.4 Positionality Statement

It is important to note that the author is also a young adult, having recently graduated from undergraduate university and has seen informally the effects that neglected sleeping habits has had on his peers. Having lived with, attended class with, and having taught young adults throughout university, I have witnessed many occasions where lack of sleep, lack of sleeping routines, etc. was detrimental, in both explicit and implicit contexts. Additionally, at points in my life I have considered myself also subject to having extremely poor sleep health. This implicates an inherent bias that I may hold, and wish to have the reader be aware of – that I hold a strong desire to improve the lives of young adults and students by trying to determine reasons why this lack of proper sleep health is not present in many students, and how to insert such habits. I ask that you read this paper with this positionality in mind.

Chapter 4: Findings

4.1 Characteristics of Sleep

4.1.1 Sleep Duration, Waketime, and Bedtime

I begin by visualizing contextual data surrounding sleep to gain a better understanding of this sample population. The participants' average total sleep duration was 7.60 hours (SD = 2.09 hours), ranging from 0.5 hours to 13.5 hours. This average sleep duration did not appear unusual – the average college student in general gets around 7.0-7.5 hours a night on average (Kamenetz, 2016). A distribution of these sleep durations is shown in Figure 4.1.

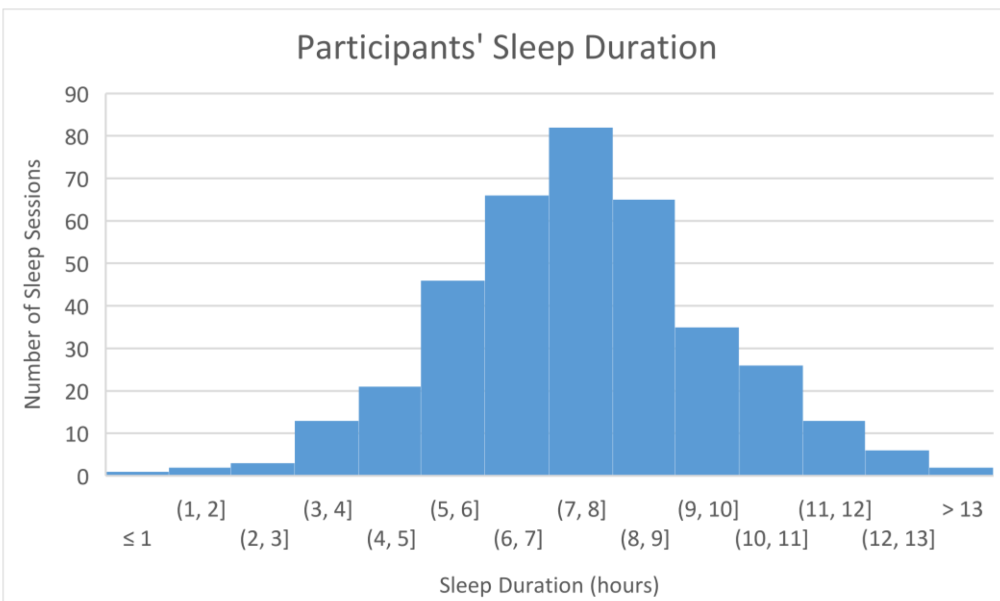

Figure 4.1: Counts for hours slept each night of all participants grouped by hours.

The participants’ average wake-up time was found to be 8:44 AM (SD = 1.97 hours), ranging from 5:00 AM to 3:00 PM. The average participant’s bedtime was found to be 1:08 AM (SD = 1.70 hours), ranging from 7:00 PM to 8:00 AM. Distributions of each of these times are shown in Figure 4.2 and Figure 4.3. While an average quarter-to-nine AM waketime and past-one-AM bedtime may seem late in both areas to an adult working the stereotypical 9-to-5, this average overall sleep schedule may be normal for a college student’s schedule.

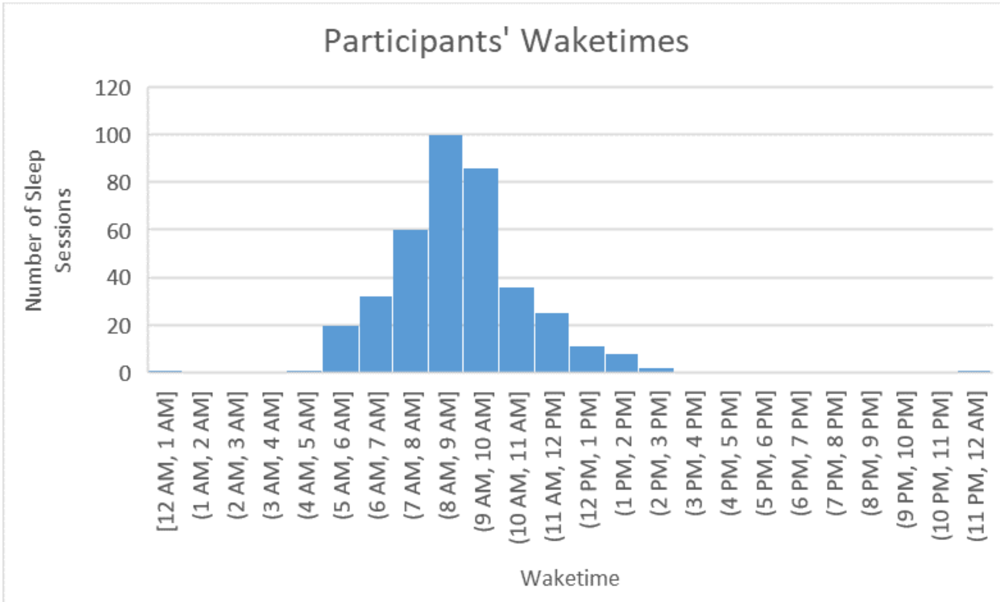

Figure 4.2: Counts for waketime each day of all participants grouped by time, starting at 12 AM (midnight).

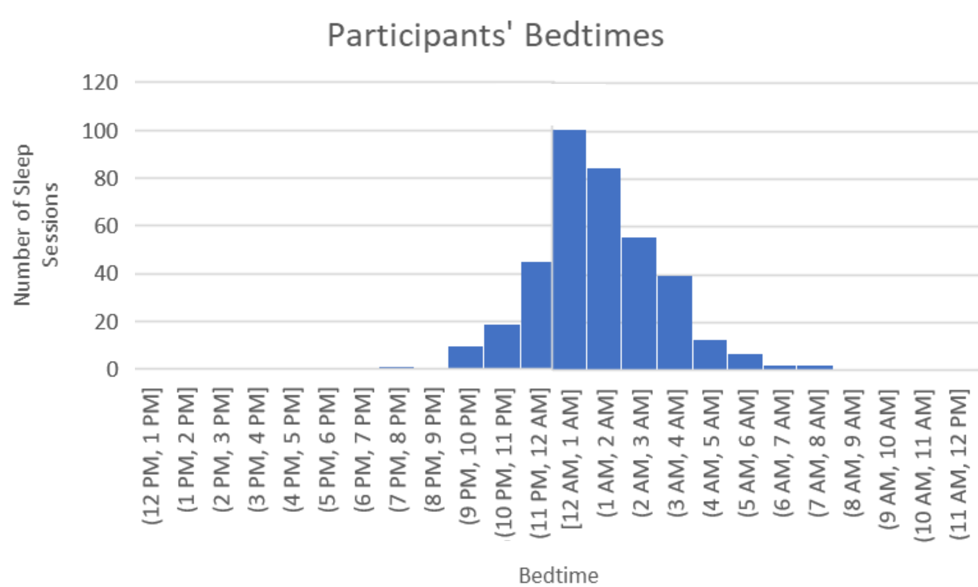

Figure 4.3: Counts for bedtime each day of all participants grouped by time, starting at 12 PM (noon).

It is interesting to note that while the average sleep duration, bedtime, and waketime of all participants are not exceptionally abnormal, the range of which sleep duration occurs appears substantially large – 13 hours. This wide range of sleep durations indicates the existence of a lot of cases where abnormalities on specific days likely occurred, specifically in the < 6-hour and > 10-hour groups (but not limited to). These cases of very low or very high sleep durations are investigated and corroborated further in the qualitative analysis of this study. Additionally, there is a notable difference when comparing the difference between the participants' average *intended* bedtime versus their *actual* bedtime. The average participant's intended bedtime was found to be 12:25 AM (SD = 1.39 hours), ranging from 8:00 PM to 7:00 AM. The participants' intended bedtimes are shown in Figure 4.4, and plots comparing the intended betimes and actual bedtimes are shown in Figure 4.5.

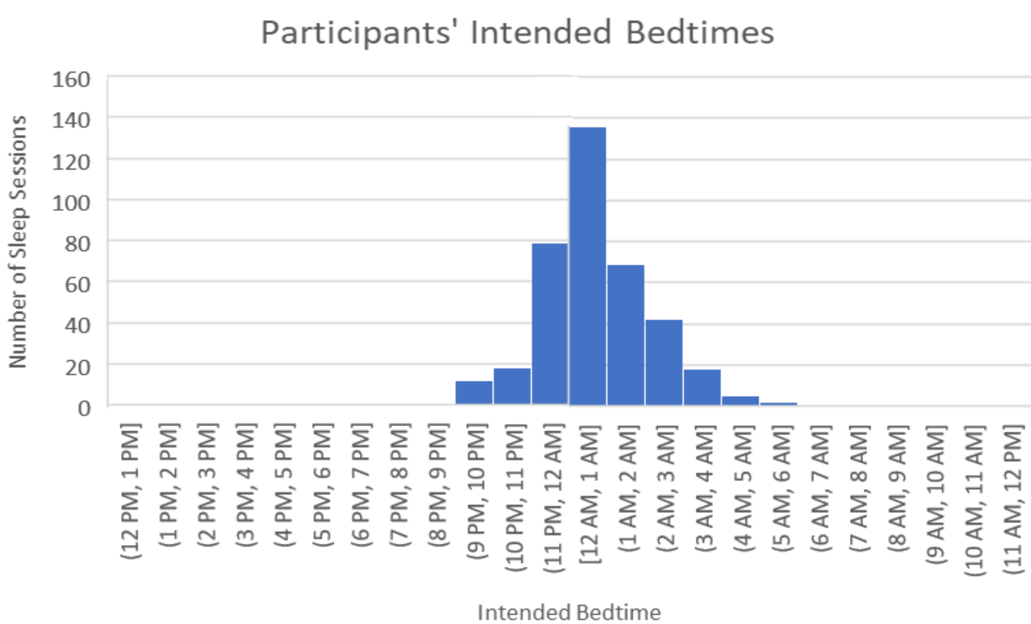

Figure 4.4: Counts for intended bedtime each day of all participants.

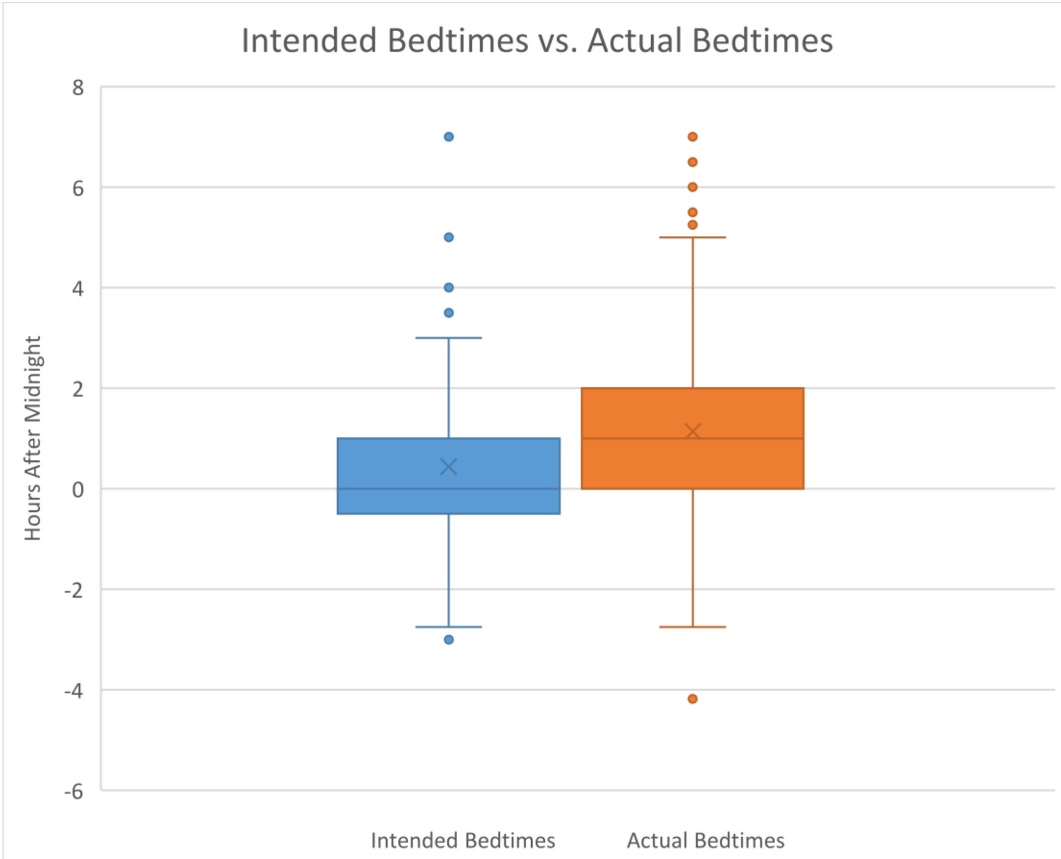

Figure 4.5: Plots comparing intended bedtime and actual bedtime for each day of all participants.

There appears to be a noticeable difference in the times participants wished to get to bed and when they actually did get to bed – the main crux of this study. This difference between intended bedtime and actual bedtime is defined in this context as sleep latency. To determine whether this was significant, further statistical investigation is conducted in the next section.

4.1.2 Sleep Latency

The sleep latency, defined as the difference between a participant's desired bedtime and actual bedtime, was computed for each night for each individual. In cases where this was not due to a pressing issue or activity that must have occurred at that time, sleep latency would be the same as bedtime procrastination. The average sleep latency per night for all participants was 44.2 minutes (SD = 64.53 minutes), and a scatterplot in Figure 4.6 shows the sleep latencies of all days grouped by participant.

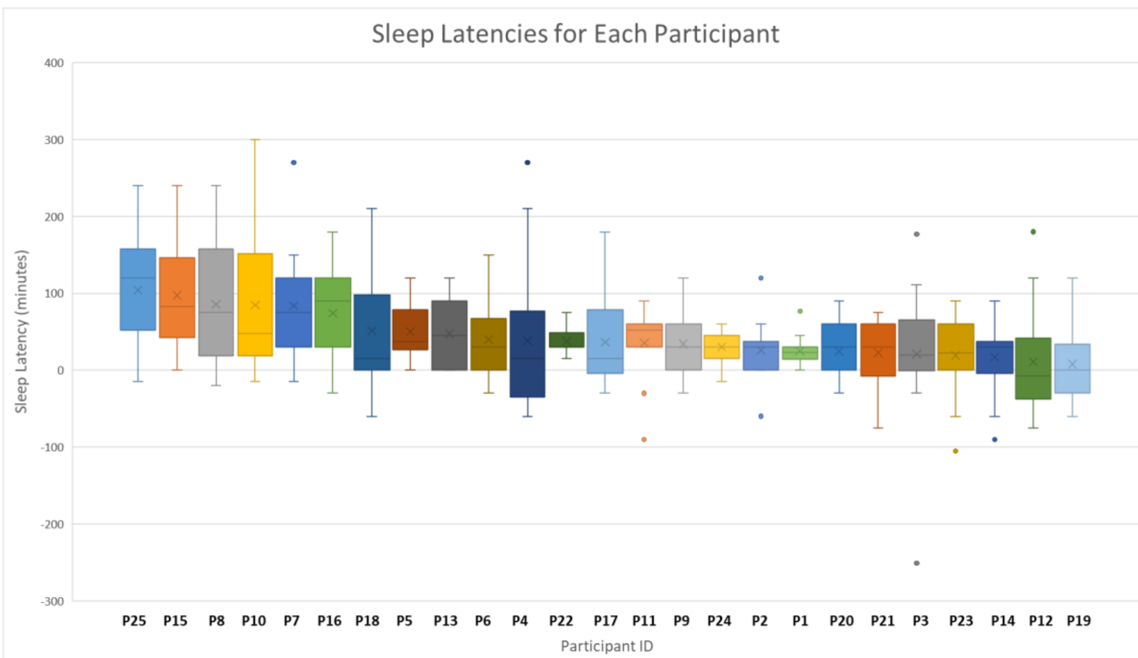

Figure 4.6: Individual sleep latencies for each participant across all nights.

As seen in the above plot, a large majority of participants' nights included a significant positive sleep latency past the time they had originally intended to sleep (none had an average below zero). A heatmap of each individual data point obtained for participant's sleep latency in Table 4.7.

Date	6/14/2021	6/15/2021	6/16/2021	6/17/2021	6/18/2021	6/19/2021	6/20/2021	6/21/2021	6/22/2021	6/23/2021	6/24/2021	6/25/2021	6/26/2021	6/27/2021
P1	15	45	22	30	0	15	30	77	15	30	28	0	14	25
P2	30	30	30	120	60	60	15	15	0	0	-60	30	30	0
P3	6	10	177	-30	82	17	-251	0	30	60	60	-1	22	111
P4	-30	76	-30	30	80	0	70	210	-50	270	30	-60	0	-60
P5	30	75	60	45	90	30	15	0	0	30	120	60	30	120
P6	30	0	60	-15	0	-30	0	60	150	30	60	90	30	90
P7	90	105	-15	60	120	90	270	120	60	0	60	30	150	30
P8	-15	30	45	90	210	180	150	105	100	-20	-15	40	60	240
P9	45	30	0	0	75	60	60	30	0	0	30	-30	60	120
P10	30	55	110	35	25	300	240	0	60	0	-15	155	150	40
P11	45	30	60	90	30	60	60	30	60	30	60	-30	60	-90
P12	30	75	-15	180	-60	30	120	0	-30	-75	-60	0	-30	-15
P13	64	30	0	60	105	60	0	30	120	90	0	90	15	0
P14	90	-60	0	0	30	60	30	90	30	30	-15	30	15	-90
P15	70	140	20	216	50	95	165	130	60	60	0	240	20	100
P16	30	90	60	90	180	150	30	90	-30	-15	90	30	120	120
P17	90	-30	180	15	-15	-30	15	15	75	90	60	30	0	15
P18	0	0	60	90	0	90	210	30	-60	0	0	120	180	0
P19	0	60	30	-30	-30	-25	30	-30	45	-60	0	0	0	120
P20	90	30	30	-15	0	60	30	30	0	0	0	60	60	-30
P21	30	65	15	75	-75	60	5	60	-45	50	-45	60	30	30
P22	30	30	60	30	45	30	30	30	30	30	15	30	75	60
P23	0	60	60	15	0	90	90	0	60	-105	-60	0	30	30
P24	30	15	15	15	30	45	-15	60	45	45	20	30	30	60
P25	120	120	150	120	240	90	180	60	30	-15	120	0	60	180

Table 4.7: Heatmap table of individual sleep latency instances in minutes for each night for each participant.

This table color-coded to help visualize where higher sleep latencies existed amongst the dataset, with red cells indicating positive sleep latency, green cells indicating negative sleep latency, and white cells indicating no sleep latency (with a darker color indicating a higher magnitude of the latency, in either direction). Figure 4.8 also includes the sleep latencies grouped by each day of the survey portion of the study.

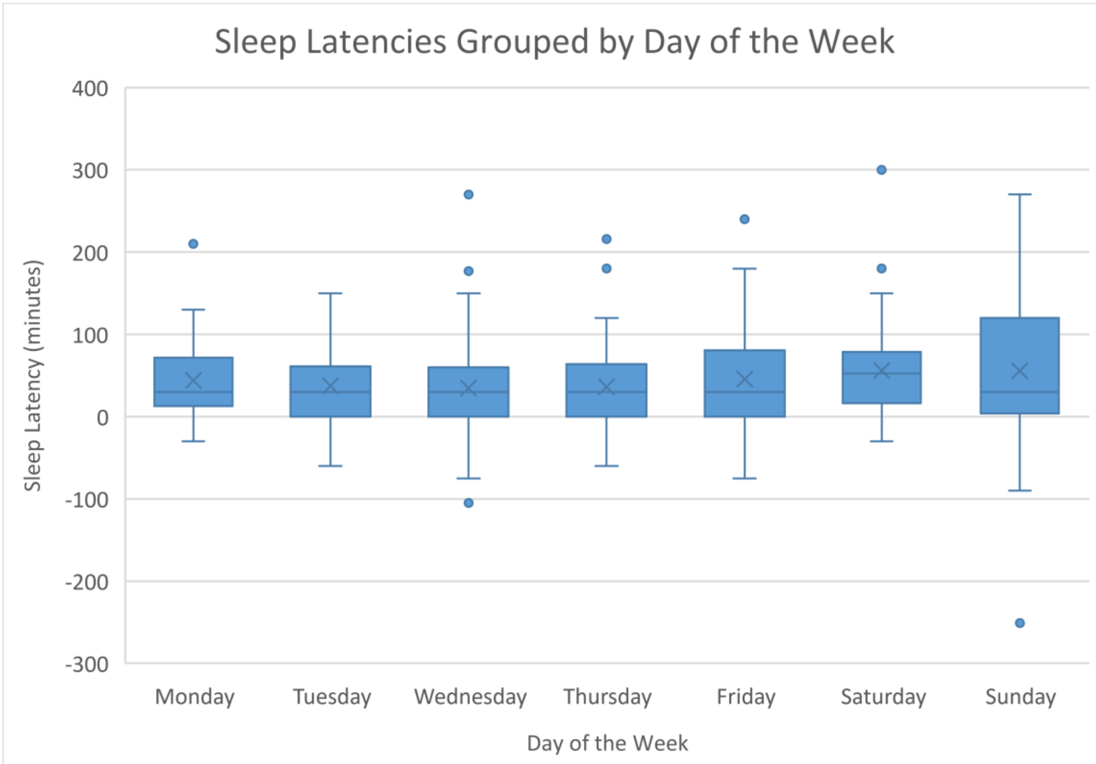

Figure 4.8: Box-and-whisker plots of sleep latencies of all participants grouped by day of the week during the study.

Sleep latency varies more for participants on each Sunday night of the study. As expected, many participants had weekend schedules that differed from their weekday activities.

To investigate whether this difference between intended bedtime and actual bedtime (sleep latency) was significant, I first plotted sleep latencies for all sleep sessions to observe the distribution of the data, shown in Figure 4.9.

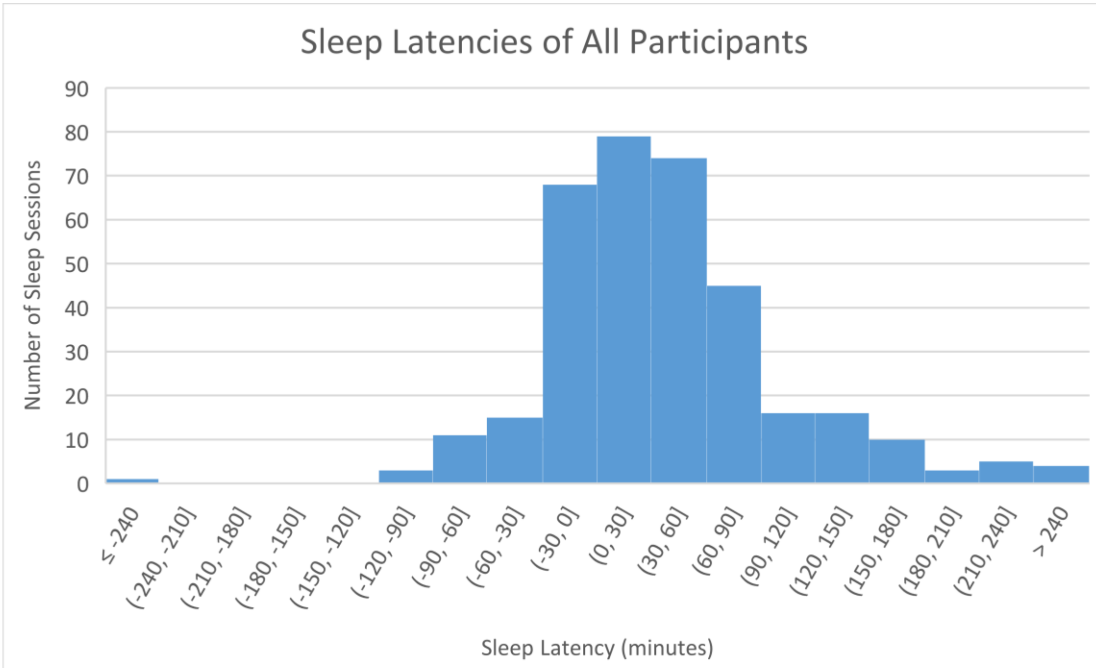

Figure 4.9: Distribution of sleep latency (actual bedtime - intended bedtime) of all participants for all sleep sessions.

This distribution appears to skew right and has a mean value greater than zero. To this end, a paired-samples t-test was conducted to compare the times between participants' intended bedtimes and actual bedtimes. There was a significant difference in the times for intended bedtime (*M*=12:25 AM, *SD*=1.39 hours) and actual bedtime (*M*=1:08 AM, *SD*=1.70 hours); $t(24)=3.42$, $p < 0.001$. These results suggest that participants' actual bedtimes are significantly greater than their intended bedtimes and provides evidence towards this existence of commonly delayed sleep in our student participants.

This bedtime procrastination present in participants is of particular interest and motivates my investigation of what reasons and rationalizations lead to such procrastination. I delve deeper into this question by examining what types of activities participants are doing close to bedtime.

4.1.3 Pre-Bedtime Activities

After completing an affinity analysis on the activity matrix of each participant, I discover the kinds of activities participants are engaging in close to bedtime (within 2 hours of sleeping). A summary of all activities completed among all participants is shown below Figure 4.10.

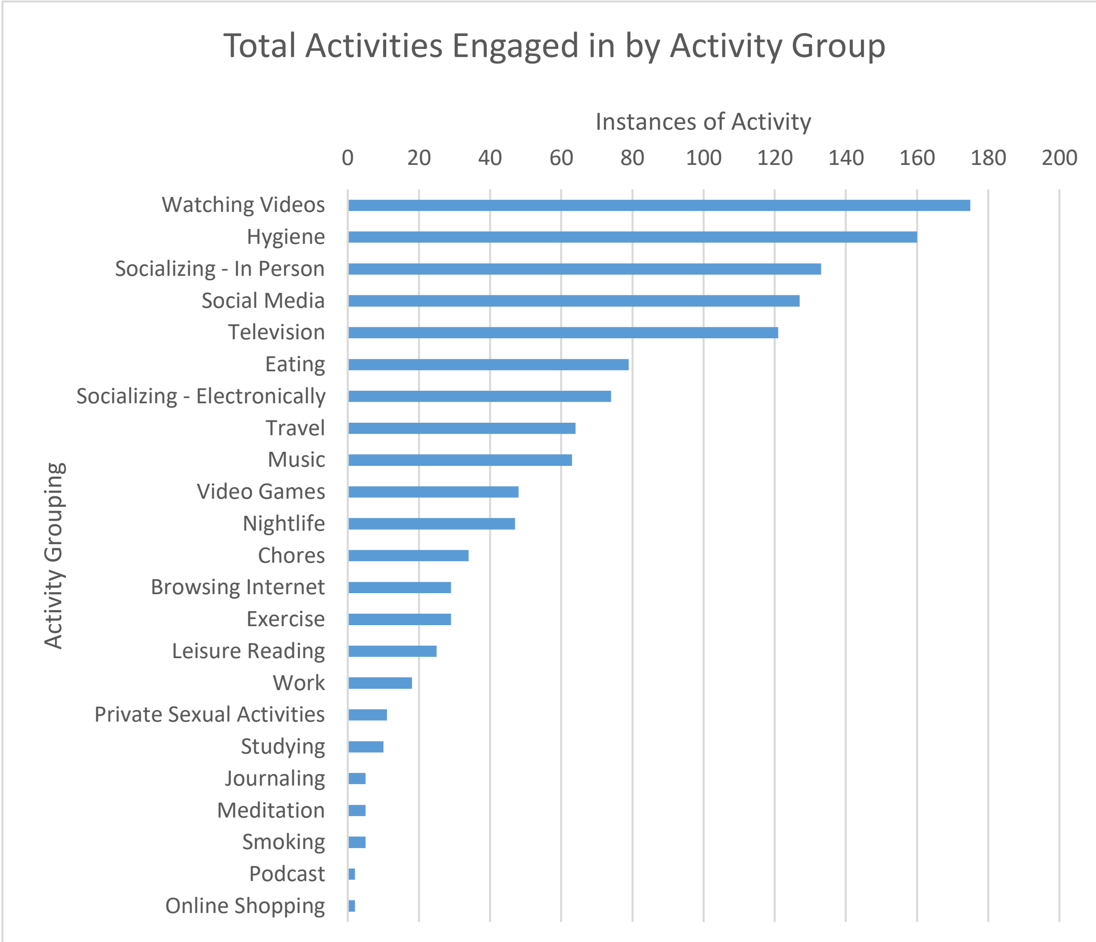

Figure 4.10: Bar graph showing counts for each activity instance across all participants and all nights.

The top five activity groupings – Watching Videos, Hygiene, In-person Socializing, Social Media, and Television – all rank very high and almost in their own separate echelon of how often they were performed by participants. The fact that 3 of these activities directly involve screen usage is particularly interesting as well, and indicate a possible key reason for bedtime procrastination.

I also wanted to see what types of activities were "must-dos" for participants – things like completing an assignment with a deadline the next morning, a scheduled work shift, or other commitments deemed as *mandatory*. Other activities would be deemed as *self-imposed* – activities that participants did not have to do, but chose on their own prerogative and did not necessarily have to do at this time. This would encompass many other activities such as watching TV, playing video games, browsing social media, etc. For each activity, participants were asked whether this activity was mandatory or self-imposed, and aggregate results for each participant are listed below in Table 4.11.

PID	Total Self-Imposed Activities	Total Mandatory Activities	Proportion of Mandatory to Total Activities
P2	15	27	0.64
P13	23	20	0.47
P7	20	16	0.44
P22	17	13	0.43
P9	23	17	0.43
P8	31	21	0.40
P19	19	12	0.39
P1	29	18	0.38
P24	42	23	0.35
P14	36	15	0.29
P11	38	15	0.28
P5	33	12	0.27
P23	39	14	0.26
P16	23	8	0.26
P4	18	6	0.25
P6	18	6	0.25
P12	21	5	0.19
P15	49	10	0.17
P17	39	5	0.11
P3	36	4	0.10
P18	21	2	0.09
P25	30	2	0.06
P10	41	0	0.00
P21	30	0	0.00
P20	36	0	0.00

Table 4.11: Instances of mandatory activities, self-imposed activities, and proportion of mandatory activities to all activities of all nights for each participant.

One thing to notice is that all participants except P2 were completing more self-imposed activities than mandatory. There also is a wide range in how many mandatory vs. self-imposed activities were performed overall near bedtime for each participant – this is explored deeper in section 4.2.2.

From all of these visualizations, I find it clear that no participant was found to exhibit entirely on-time sleep every night, and that every participant had some level of sleep latency on average throughout the survey study. Possible correlations with sleep latency and types of activities are explored next.

4.2 Reasons and Rationalizations for Bedtime Procrastination

4.2.1 Pre-Bedtime Screen Time

Electronic screen usage close to bedtime is known to have ill-effects on sleep due to blue light emitted from devices that negatively affects an individual's circadian rhythm. However, with the increase of "night mode" (where a screen or device blocks blue light from being emitted) and special blue light reflecting glasses, it becomes harder to deduce finer-grained factors regarding screen-usage that may negatively affect sleep. Most participants had already been using night mode or blue-light filtering glasses throughout the course of the study, without prompting. To investigate how screen-time as a whole affects the University students in this sample, I plotted the average sleep latency of each participant (with sleep latency defined as the difference in minutes between a person's pre-planned bedtime and their actual bedtime) against the proportion of total screen usage activities to all activities (with screen usage activities denoted as those involving T.V., social media, videos, video games, and browsing the internet). For example, if a participant engaged in 100 total activities over the two-week diary study, and 30 of those activities involved screen-usage, that participant's proportion score for total screen usage activities to all activities would be 0.3. Figure 4.12 depicts this relationship for all participants, and Figure 4.13 depicts average sleep latency vs. total screen usage activity instances, rather than a proportion, for all participants.

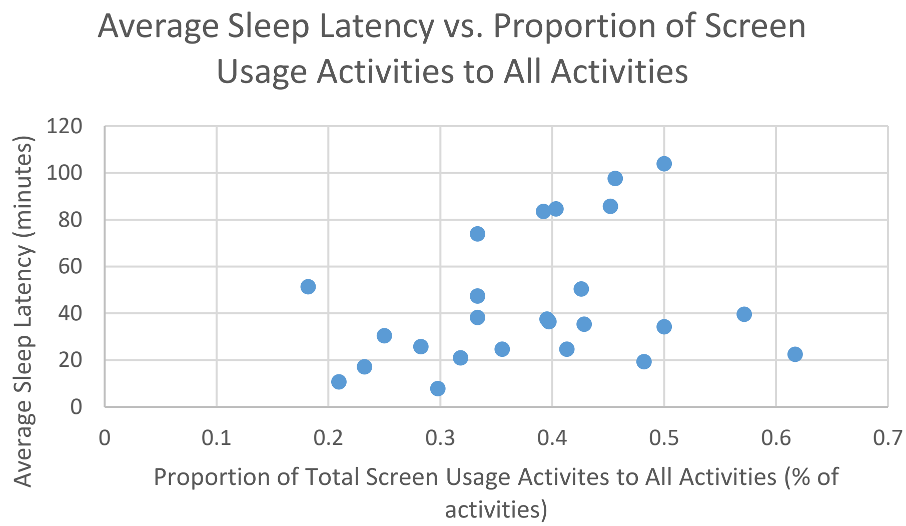

Figure 4.12: Depicts the relationship between average sleep latency and *proportion* of total screen usage activities to all activities of each participant.

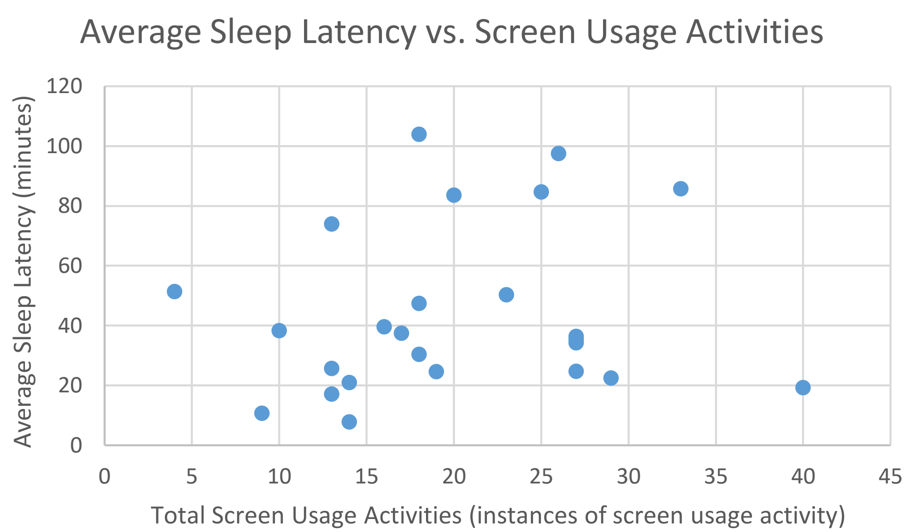

Figure 4.13: Depicts the relationship between average sleep latency and total screen usage activities of each participant.

A Pearson product-moment correlation coefficient was computed to assess the relationship between average sleep latency per participant and proportion of screen usage activities to all activities per participant. There was a weak, positive correlation between the two variables, $r = .0781$, $N = 25$; however, the relationship was not significant ($p = .711$). The average sleep latency per participant did not appear to be associated with the proportion of screen usage activities to all activities per participant.

Despite the non-significant result, it seemed that participants spent a long time on screen activities before sleep. Many participants appear to be well-aware of their general tendency to view screens close to bedtime on either multiple occasion during the week, or even as a bedtime routine. Furthermore, these participants even understand and experience the negative effects that can come from this late-night screen viewing.

> *"I'm trying less to like, just like play games and stuff at night and like do like more like mundane things that are like put me to sleep. And like, I've been able to like my sleep definitely improved because of that, I feel like." [P1]*

> *"Sometimes I would consciously like turn off my phone and put it face down, like close to my bed instead of actually being on it. And while I was conscious of this decision when I did have that thought in my head… I [should] actually do something like better to like get better sleep. But if I didn't, if I didn't like, remember I had to do the study the next morning, I usually would probably just stay on my phone." [P4]*

"And like a lot of the times I get bad sleep, my mind is in a more active state cause I was playing video games and I was being, you know, my mind was active. Right. And like the days that I don't is when I, I read or I relax, or I don't do anything." [P23]

These participants have found noticeable differences that between days they do use screens before sleeping and those that they don't – P4 even goes as far to mention that if they have something particularly important the next day that they purposefully will refrain from screen-viewing just to ensure a better chance of obtaining good sleep. P4 also mentions that if they remember that they need to study the next morning, then the choice to not use screens near bedtime becomes more apparent. This awareness of one's activities influencing a better habit choice indicates the importance of mindfulness – both during the day and night. This idea of mindfulness is visited again in the following excerpts:

"Well, filling [the survey] out every morning, kind of made me realize how little sleep I get and how I definitely should try to get more. And like, I like made me realize like the phone, like go going from before that is just like, I guess, such a time waste of time and like a sleep killer. Like if I like getting an hour, extra of sleep could easily happen if I just put my phone down a little bit earlier." [P16]

> *"Typically I almost universally regret watching YouTube on my phone at night, which pretty much always pushes my bedtime back." [P24]*

P16 makes an interesting comment about how filling out the survey – an increase in mindfulness – made them realize that they were getting less sleep than they thought, along with the likely "sleep-killer" that is the phone. This mindfulness of their habits ultimately leads to an awareness of this consequence, and the participant later indicates a wish to change now that they are aware of this. However, it's interesting to note that P24 almost "universally regrets" watching YouTube before bed, yet had not made a change in the past to fix this. This failure to enact personal habit change previously further indicates the potential for individuals to self-track and reflect on their feelings and activities surrounding sleep to ensure change is possible for them in the future.

I find from these anecdotes, and from a majority of participants, that these University students are typically aware of poor screen-viewing habits, and even how detrimental they can be, but still choose to do them without proper self-tracking and reflection. Participants were found to have high rates of screen-viewing activities near bedtime and high average sleep latency throughout the study. I now further investigate some reasons and rationalizations for why these activities are done against the participants future best interests'.

4.2.2 Mandatory Activities

I would argue that a mandatory activity that is especially crucial to perform that day or evening would be a justifiable reason to delay sleep, if this is kept to an occasional basis. However, I am curious as to if a reason such as this is a prominent or consistent one for keeping people up at night against their best wishes. I wanted to see if participants who completed mandatory activities more often subsequently had higher average sleep latency. To do this, I plotted two pieces of data obtained previously – participants' total mandatory activities as a proportion of their total activities versus their average sleep latency for the study. This is shown in Figure 4.14.

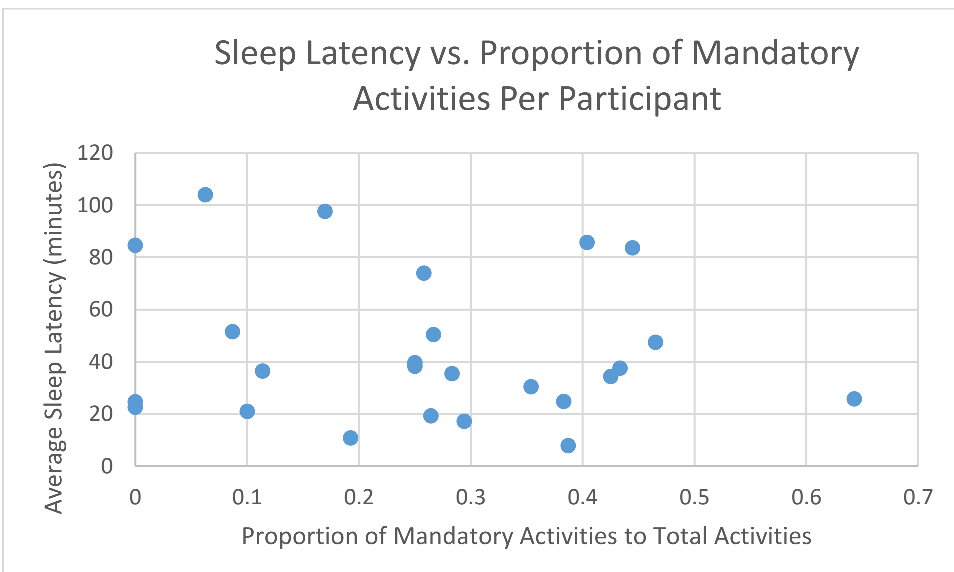

Figure 4.14: Depicts the relationship between average sleep latency and *proportion* of mandatory activities to all activities of each participant.

A Pearson product-moment correlation coefficient was computed to assess the relationship between average sleep latency per participant and proportion of mandatory activities to all activities per participant. There was a weak, positive correlation between the two variables, $r = .020$, $N = 25$; however, the relationship was not significant ($p =.924$). The average sleep latency per participant did not appear to be associated with the proportion of mandatory activities to all activities per participant. Moreover, there was no substantial evidence in the interviews to indicate a relationship between the two existed. While no relationship was found here, it is interesting to note because whether or not a participant was doing self-imposed or mandatory activities seemed to have little-to-no effect on how much bedtime procrastination was occurring. This was surprising, as I had initially thought that participants' mandatory activities engagement would have a stronger relationship with their sleep latency versus simple self-imposed bedtime procrastination – but this appears not to be the case. I instead find other reasons when investigating further into the participant interviews.

4.2.3 Bedtime Distractors and Social Expectations

While screen time is one factor that is detrimental to one's sleep latency, I delve deeper to uncover some particular aspects of how sleep latency is increased. I discover that distraction is a key component of this delay – on and off the screen.

> *"There are certain days I think, where like, you know, I was like Snapchatting people or like up too late with my brother watching videos or like that one night*

where like I knew I had to wake up at six or seven, I will go to 6 55 that day. I went to sleep at three 30. So there's definitely like a lot of days where I've regretted, falling asleep as late as I did." [P17]

"I waste way too much time [...] It's just like five minutes, turns into 10, 15, very quickly, very quickly. Like I said, I am getting angry at myself and then I'm like tossing the phone across the room. And then I slept earlier." [P19]

P19 indicates how they will try to just spend five minutes on a phone-related activity, but how this can snowball into longer amounts of time – so much so that unpleasant emotions even arise. Distraction, and losing track of time are present themes in these responses. The subsequent regret of P19, along with P17's, is very common among participants:

"I do know that consistently one of my problems is I get in the bed and typically I'm pretty good about only being on YouTube for like 10 minutes, but occasionally I'm, I maybe, you know, get lost in a YouTube rabbit hole and probably I'm in there for like 30 minutes, maybe 40 in like really bad scenarios. And that I regret. That is not good." [P24]

"So that I tend to be like watching TV and stuff like that. And like, it just gets like interesting. So then you'd be like, well, like one more episode, one more episode. It's like, kinda like, binge-watch it. And then like I ended up sleeping

at like 5:00 AM or something like that. And then like the next day, I'm just like, oh, like I could have like slept earlier and woken up a little earlier and like gotten more done. Instead of just watching like a bunch of TV." [P25]

"I just think, I think it was like usually like they end like the episodes on a cliffhanger and I just like really wanted to know what happened next. So I kind of like gave into that curiosity and just kept watching more and just like, yeah, I just kept watching a few more episodes and then it ends up being like an hour or two more." [P25]

The general theme present within these responses is that participants aren't thinking about sleep when engaging with some screen activity near bedtime – from video-watching to Snapchat socializing – because this quickly turns into a distraction from the need to actually begin trying to sleep, which further increases sleep latency. The regret they feel the next day is real, and discussed prominently in the interviews, but this is not enough to enable participants to consciously make the decision to stop the distracting activity while performing it. The key factor I find in this idea is that *during* the activity is where this conscious or unconscious decision-making is particularly difficult. This is likely due to the nature of the screen itself (being an artificial source of light that affects circadian rhythm), desires to "finish" the activity (completing an episode of a T.V. show or YouTube video), and social endeavors (talking with friends, finishing conversations, and assisting others). Even aside from screens, participants talked of struggles to achieve on-time bedtime due to social instances.

> *"I would come home from my friend's house and then I would come back and like get back like 1130 and then start talking to my stepdaughter. Next thing I know we're talking for 45 minutes, like, so it's kind of just like one thing led to another and then I'm backed up a little bit." [P5]*

> *"Or like, it would be days where I'm like having a really good time with my brother, like watching YouTube videos or doing stuff like that. And I'm like, I want to spend time with my brother. I don't want to miss out on that. So like, I'll stay up with that. Or like, there'll be days where like, I'm having a big conversation with someone. I don't want to like, like stop that to go to sleep. So there's a lot of days where like I have that FOMO."* [P17]

Both P5 and P17 discuss how they begin social endeavors some time before bed, but continue to do so even past bedtime due to a want to continue their social endeavor. They are effectively deciding that they value this social experience over their desired bedtime – and as P17 puts to, to appease his FOMO (fear of missing out). While this can appear to be based in participant's desire to socialize, I find after obtaining contextual information from participants that often this decision is placed more in an act of selflessness – a want to help or engage with the other party for their sake. P4 puts it well:

“I guess some of the stuff that was like self-imposed was actually stuff that I felt I had not, I ha yeah, like stuff I didn't have to do, but I felt like I should, for other people I don't ever, like, I feel like some, like some of the stuff there is like talking to girlfriend, hanging out with friends, like those were all things that I felt like I should do not because of really how I felt in terms of like wanting to go to sleep, but just something that I should do for like someone that I care about.” [P4]

P4 shows a rationale here that while they are aware that some social endeavors were likely not necessary (“didn’t have to do”) to complete for delaying sleep, but because they were something they felt they “should” do. The rationale is based in because they value the other person’s wants more so than their own sleep – an act of selflessness. This was a particularly interesting findings; many participants realized how important it was to go to sleep soon, but consciously chose not to engage further with others. I would argue that this feeling may even be due to innate human instinct to help others, even if it is to the detriment of themselves.

<u>4.3 Sleeping Routine and Habits</u>

4.3.1 Habitual Poor Sleeping Habits

Humans are very good at creating and maintaining habits in their life, sometimes to their own detriment. When asked what participant's thought their reasons for delaying their bedtime were, many described they have made it a habit of doing poor choices of activities near bedtime.

> *P11: "I'm not content. I would, I think all the activities I reported other than like getting ready for bed, I was on my phone or some kind of technology and that's for almost two hours. That is not good in my opinion. So I would definitely love to take technology time out of my like nighttime routine more than just actually getting ready for bed."*
>
> *MP: "Yeah. So what do you think is stopping you from doing that?"*
>
> *P11: "I guess my habits of myself being very used to falling asleep, like I think I've just totally lost touch of what it's like to put my phone down and be like, all right, I'm ready to sleep. Let me close my eyes. I've just gotten so used to hearing something, whether I am right. Whether that's like a more relaxed video with music or something or whatever comedy interview, something I'm watching, I've gotten used to that falling asleep. And I guess not used to silence and right. Just the whole like, okay, I'm going to actually go to bed now."*

P11 describes this habitual use of their phone right before bed almost as a sort of lost knowledge of how to sleep normally, mentioning how they have "totally lost touch" of what it's like to sleep without that phone use. This indirectly expresses an inability to break those habits, at least without substantial effort. P5 even describes how they cannot "go right to bed" without such usage:

> *"Yeah, I usually, I just watch YouTube videos. It's either YouTube videos or TikToks. I don't, I honestly don't remember the last one I've kind of just got home, went to bed and then went right to sleep. Like I always had to like go and take TikTok or like, I go usually YouTube videos when I have my computer […] but like most times, like I can't just go right to bed."[P5]*

These habits are often so engrained that the individual doesn't even consciously make decisions to perform these activities close to bed – it sort of just "happens" so often that the participant cannot remember the last time they were without. While habitual distraction at nighttime was typically observed to be an unconscious decision, I wanted to try to uncover how a participant might subconsciously rationalize this. When one participant was directly asked this question, they gave an interesting response:

> *MP: "Is it more of like a distraction loss of time or is it a conscious decision that you're making?"*

P24: "I, I want to say that it's kind of like, I don't know if it's a conscious decision. It's kind of like a voice that I let slide in lieu of other good habits is the way I rationalize it. I would say, hey, I feel like, you know, if I'm stretching and meditating and I went to the gym that day and I made my food, I'm like, ah, you know, I can let this one slide. But typically it's, it's pretty habitual. I would say, I don't think too much about it. I just kind of get in bed and then, you know, maybe 30 seconds later, my phone is in my hands, so."

P24 indicates how they are aware of the poor choice they are making, but they "let it slide" because of all the other good decisions they are making throughout the day. This can be viewed as a sort of "reward" that the participant is giving themselves to help perpetuate the other good habits, at the expense of higher sleep latency. One could argue that this is better than the alternative of having poor habits in other areas of life just to maintain a proper sleep schedule. P11 articulates a similar feeling:

"I've wanted to do more before bed rather than looking at my phone, but it's been very difficult to actually implement just more of like reducing my eyes on lights and something that would actually settle my mind ready for bed versus, oh, I've worked my body so hard all day, not to force myself to go to sleep." [P11]

P11's comment of "oh, I've worked my body so hard all day" is an indirect link to the idea portrayed above – that participants feel like they almost deserve a break of some enjoyment or something easy to consume, rather than making a conscious effort to implement a better sleep activity. This idea of trying to do a more "relaxing activity" at night versus screen-time actually can require effort from the participant since this is a break in their normal habit – sometimes an effort not worth making in the eyes of the participant after a long tiring day. Overcoming these habits pose a greater challenge to the individual over submitting to their normal routine, even if it is one detrimental to their sleep health.

4.3.2 Post-Study Improved Sleeping Habits

While this study was intended to be exploratory in nature, it is important to note the effects it had on the participant's sleeping habits and how they view sleep health now having completed diary entries for 2 weeks. Every single participant noted at least some level of increased awareness after having tracked their activities every day, which is not surprising, but certainly a positive outcome. More notably, a large majority of participants described that they wanted to make changes, or already have been making changes, to their sleeping habits after completed the study. 24 of the 25 participants answered yes when asked if they thought they would make a change to their sleeping habits after completing this study. This desire to improve sleep habits post-study are well discussed in the participant interviews:

"It was eye opening kind of, I really thought I did get more sleep. [I'm] kind of realizing you know, not, not enough at all and I'm going to try, I'm going to try to get better." [P16]

"Like, I always think I'm going to sleep on time. Like for the most part one o'clock tends to be around one, but it also showed me how the impact of two really late nights." [P19]

"And it makes me more conscious about what I'm doing. [...] One of the things I want to start to change and I've been doing the last three days after the study; instead of using my phone as much, I've just saved my reading for before bed. And I did that a few times during the study, but looking at how often I was on my phone in bed and not doing something that wasn't fun related, I kind of sat there and I was like, I know I should be doing this. I know this is the right thing. [...] So I've been trying to really follow that trend of like mentally winding down, stepping away from like digital stimuli using a book. That's the biggest thing, you know, once you see what you're actually doing, it's the same thing with dieting, right? Like once you see what you're eating throughout the whole day, you've realized like, oh, that was a problem the whole time. And I just never wrote it down and looked at it." [P23]

"I would say like, got me thinking about it. Like, it's something that, like, I didn't think about a whole lot. I just kind of go to bed, like whatever, but it's, it's been,

it's just, it's just kinda like raised the question, like, are my habits healthy? Like, what am I doing to make myself like, like better?" [P2]

P2 describes how sleep habits are "something that, like, I didn't think about a whole lot" and P16 notes how they "really thought [they] did get more sleep." This indicates a sort of "glossing over" of their sleeping habits previously – while not purposeful, but may suggest unawareness or a lack of importance placed in these habits previously. Many participants' shared P16's comment that they did not realize how little sleep they were getting overall. The lack of awareness or misplaced ideas of what their habits are actually like indicate a need for more individuals to be conscious and present when it comes to activities they are doing at night and sleeping habits in general. I find that because many of our participants were previously unaware or thought their habits were OK that there was no need for change or action, which was shown not to be the case once participants had completed the study.

P2's questions of "Are my habits healthy?" and "What am I doing to make myself […] better?" are great examples of the impact of self-tracking and positive reflection. Asking these personal, and sometimes often tough, reflective questions are crucial in beginning to enact change. I am very pleased to discover that participants are asking themselves these questions after the study. Additionally, while all participants noted increased awareness and most indicated they wished to improve upon their habits, many also were able to pinpoint particular aspects of their habits that they found detrimental to them.

"I would say it definitely made, it drew attention to… I think the main thing it did is that it drew attention to specifically the YouTube thing. I already kind of was aware that I was doing that, but as I was looking at my activity list and as I was writing them out, I kept thinking like, oh, this isn't bad. And then it was always that last activity that I have to write down. I'm like, oh man, like I do that every night." [P24]

P24 speaks of how they were aware that they would watch YouTube in bed sometimes, but became uncomfortably aware that they were actually doing this every single night. This realization is important to note, especially when trying to make changes in lifestyle, as one cannot begin to take action against a problem they are not even aware of. P20 describes in detail this notion further:

P20: "The one thing that I noticed from recording my sleep was that when I [my favorite] crime comedy show […] I get worse sleep. And I tend to have nightmares about like being robbed or something which follows logically because like it probably kind of puts me on edge and makes me think about crime. I noticed that I also, like during the study, my sleep time started to get earlier. So at the beginning, probably before I even started doing the study for the past, like few months I had been getting up at 11:00 AM and I was really stressed. But then throughout the past couple of weeks, my sleep time has like been going earlier and earlier, and now it's at like 9:00 AM when I wake up in *the morning. So I think like I noticed that from this study. And I think it's because I like have been a lot less stressed lately, so it's been easier to get up in the morning."*

MP: "So you think it's easier to get up when you don't have any impending stress?"

P20: "Yeah. Well, I was stressed about like for the past couple, few months I was really stressed about getting a job and like, I was like applying for like tons of jobs every day. So like I would like delay getting up in the morning cause I was just so like stressed all the time. But now that I like am not really stressed cause I have like a job I like and stuff. It's like less heavy for me to get up in the morning and I noticed that like I kept getting up earlier and earlier."

Here, P20 was able to identify two specific problems: that their crime-show watching was negatively affecting their sleep, and that a low-stress schedule helps perpetuate an earlier wakeup time and perceived increased overall sleep health. Without tracking and reflecting on their activities and subsequent sleep quality the day after for many days, P20 would likely have not identified the roots of these problems. This simple act of taking a couple minutes in the morning and/or evening to simply reflect on your activities and feelings about your sleep appears to be useful in helping identify problems such as these. I find that the effort put in for the reward in these instances is well worth the benefits gained from better sleep, as did many of our participants.

Chapter 5: Discussion

5.1 Research Question 1

5.1.1 How and Why Was Sleep Delayed?

One of the main takeaways I find in regard to RQ1 is that students tend to find ways to rationalize their bedtime procrastination, even if it is to their detriment. Especially late at night, when self-regulation resources are low (Muraven & Baumeister, 2000), deciding that helping a friend out, or deciding to "relax" with screen-time are often weighed as worth delaying sleep as found during this research. Typically, the consequences of this delay are not considered in that particular moment, and without any reflection in the moment or previous day, this type of bedtime activity is allowed to flourish without any realization of its ill-effects. Furthermore, this can eventually turn into a habit, as it had become for many of our participants at some and many points in their lives. I found that these rationalizations are powerful and can cause participant's unawareness or uncaring for change in sleep behavior. From a different perspective, sometimes rationalizations are not even present in the minds of individuals. Bedtime distractors are often initiated by either habit, or lack of willpower to refrain from a tempting activity. Once a distracting activity is initiated – for example, an intriguing Netflix episode, or TikTok's endless scrolling feed – it is often difficult to disengage. This distraction can lead to feelings of being unable to control one's ability to get to sleep at time; these individuals are sort of at the will of the distracting activity, almost powerless. While this is certainly a valid and understandable reason for bedtime procrastination, we also want to understand how we can address this issue, which is explored in RQ2.

5.2 Research Question 2

5.2.1 Self-Tracking and Reflection

One of the first steps toward making a lifestyle or habit change is awareness of the problem at hand. A substantial amount of participants indicated that the simple act of tracking their data showed them what they were actually engaging in close to bedtime, rather than mindlessly engaging in activities and forgetting the next day. However, many other participants who were already aware of their poor sleeping habits described an initial feeling of carelessness towards it, as if they did not care enough to change their ways. But after careful reflection and deeper thought on their quality of sleep made them reconsider their initial stance. Many came to a conclusion that effort put it to mitigate some of their poor habits would be well worth the proper sleep, increased energy and productivity, and overall mood gained. Effectively, this shows us that to really improve one's sleep habits, and likely other habits in one's life, it is important to not only track their data but reflect upon it too. This touches on a concept of mindfulness, commonly discussed in the domain of meditation. Mindfulness is defined as an "*awareness of one's moment-to-moment experience nonjudgmentally and with acceptance*" (Keng et al. 2011). This succinctly captures the necessities of being able to improve upon sleeping habits – being aware of their bedtime activities, and accepting that they may be causes of bedtime procrastination. Mindfulness is especially important when considering screen-time activities – as many individuals can get lost in the addictive nature of social media or video-watching. I show that tracking these activities certainly improves awareness, and a desire to improve sleep hygiene. While many participants indicated that they would make a future change to do so (24 out of 25 participants), future work would be needed to actually see how many individuals would follow through with this action.

5.2.2 Design Implications

Ultimately, practical applications of research in this thesis would manifest itself in improved designs of applications and services to the individual. Previous work has already pointed to the likely benefits of interventions before app usage – for example, prompting a user with "What were you doing before starting to use this app?" or "What were you going to do after using this?" to remind them about the alternative actions (Cho et al., 2021). These would be great additions to helping reduce bedtime distractions to activities already intended to be completed – however, in the domain of bedtime procrastination there is sometimes no mandatory activities that need be completed in place of the distraction. In these cases, or even in general, a simple reflection "entry question" is a recommendation I would give, such as asking the user "Why are you engaging in this activity at this time?" This reflective entry question to the app would be low-effort (estimated less than 30 seconds), and would have a twopronged benefit. First, this *reflective-in-action* step would force individuals to reconsider whether this activity has a valid reason for being done, rather than mindless use of an application for some expected reward gain. I predict that for many that this would already be enough to halt certain unintended screen-activity usage. Secondly, this reflective response data could be aggregated to have users visualize their own responses over time. They would be able to view their own reasons and rationalizations for using a certain application, and reflect upon these reasons in a longer period of time. Often times, participants in this research would not become aware of a poor habit until viewing their own responses surrounding a particular activity over time. This reflection would bring to light any poor habitual rationalizations the user might have and be able to fix. Depending on the nature of the application, feedback could also be provided to the individual. Applications with machine-learning capabilities could learn how other users improved their sleep, and recommend similar suggestions to the user if their anonymous data is deemed similar. Applications in healthcare could have medical providers review this data, and with the qualitative reflections doctors could provide their own recommendations after review of a patient's data.

Another design implication would be incorporating the wide array of screen-usage data present in many smartphones today already into mindfulness applications. Having users report their own usage is great, but human nature leads to forgetfulness sometimes that a smartphone can capture instead. For example, Apple's iPhone currently has a robust capture of screen-usage activities that a user can view. One downside to this is that this feature is hidden deep within the "Settings" section of the iPhone. Another is that while duration of certain activities is collected, time at which they occurred is not shown. The first suggested design improvement, from either Apple or another third-party that incorporates such data, would be to have this data more easily accessible through a home page – as self-tracking without reflection often yields much less improvement than the both combined. A second would be having this data be tracking chronologically for each day, so that a user can see when they were engaging in certain screen-time activities. An “bedtime procrastination” application would ideally capture this screen-usage data along with timestamps and show a chronological depiction of the users activities. Furthermore, a simple reminder each day to have the user reflect on this visualization would help involve the user in being mindful of this data, and possible improvements that may be necessary as a result. Cho et al. has already highlighted the need for providing a high-resolution portrayal of one’s smartphone usage, rather than having companies just collect this data without viewing from the user. Further machine-learning algorithms that help identify the intent of some application usage (for example, mandatory activities vs. self-imposed activities) would help users reflect even more greatly.

5.3 Limitations

One limitation to this study is that this sample was limited to University of Maryland, College Park students, and those of whom participated in this study. While college life is often similar in many ways to that of other colleges, cultural and societal difference may prove to affect students' lifestyles, and their sleep, in ways we do not yet understand. Things like lack of health resources or subpar student housing at other Universities could affect student's feelings and actions regarding sleep. This might yield slightly different reasons for bedtime procrastination, which may need to be explored for a better overall understanding of student's sleeping habits and their feelings towards change. Another limitation was the possible existence of participant reactivity – that knowledge of being a participant in the study may have affected some participants' behavior within the study. However, I believe that without this knowledge participants would have only exhibited even worse sleep. Some participants described improvements in sleep in the latter parts of the study – so this suggests their previous poorer sleeping habits would have been exacerbated if they had not been a participant in this study. Another limitation is when the two-week study period occurred for participants. Things like final exam week, midterm season, or other time periods may show other aspects of student's bedtime activities or stress levels that affect collected data. To combat this limitation as much as possible, I tried to incorporate holistic questions of sleeping habits in the interview questions, as well as asking if the two-week period of study collection was abnormal for any reason. I found this to capture a fair amount of the qualitative data that would be present if the study were to be conducted at another inopportune time – however further research in different or longer time periods would certainly still prove useful to better understanding this landscape as a whole.

5.4 Future Work

While this research has provided context surrounding delayed sleep behaviors and how reflection can mitigate poor behavior, there is certainly room for future research. A broader sample and added rigor of data collection could provide even more detail in bedtime procrastination across more age groups and demographics. More importantly, future research should consider design implications for applications or services that specifically target those suffering from bedtime procrastination, but not from any medically diagnosed causes (this would be better solved through medical treatment based on doctor's recommendations). These design implications should consider these reasons and rationalizations for bedtime procrastination, and participant's attitudes towards self-tracking and reflection. Most tools that enable self-tracking do not explicitly design for reflection, carrying an implicit assumption that providing access to self-tracking data is sufficient (Kocielnik et al., 2018). Designing behavioral sleep-tracking applications for bedtime procrastination with self-reflection in mind would be an excellent study to build upon this research. An already existing useful sleep-tracking tool SleepTight is a low-burden, self-monitoring technology for capturing and reflecting on sleep behaviors that is customizable in the ways users collect various sleep data (Choe, 2014). Using an application such as this would enable both the user and the research to gain interesting insights regarding bedtime procrastination, along with the myriad of other sleep data it has the capability to collect.

Further customization of SleepTight itself could include enabling the user to view a sort of roadmap of their evening activities, as well as trends over time of these activities. SleepTight already has the capability to show users visualizations in a positive light, which suggests more self-reflection and viewing of data versus negatively connotated visualizations (Choe et al., 2015). When combined with the other sleep data SleepTight collects and visualizes, reflection could occur as a much deeper level if the user is shown their daily nighttime activities in a positive light. Many participants indicated that they wouldn't really think about their poor habits previously, likely due to the negativity associated with it. A positive spin on visualizing their activities, and ways to improve upon them, would be an excellent addition in attempting to identify and tackle poor sleep habits. This finer-grained reflection would likely have more powerful change potential for the individual, and consequently lead to more proper, restful sleep. Having context of how people feel towards sleep, self-tracking, and reflection is paramount when attempting to design such an application or service, and further usability research would substantiate this work as designs are iterated.

Another design consideration for future applications to improve individual's sleep would be to try and gamify good sleep habits. Many participants described wanting to do something rewarding near bedtime for a hard day's work, but felt regret when doing screen-related activities or other poor sleeping habits. Designing an application that makes a participant feel good about performing good sleep hygiene would likely improve individual's willingness to do better activities. Research in this domain would be valuable in contributing to services that can help others in this regard.

Additionally, a longitudinal study in the same vein as this study would be an excellent avenue for future work. Understanding how participant behaviors and attitudes change over a longer period of time would provide excellent insight to the cause-and-effect relationship between self-tracking and reflecting on sleep, and the concrete benefits that participants would gain in the long-term. For example, conducting another 2-week study later in the year after this study with the same participants would allow a researcher to determine how much of an effect an initial period of this data capture affected students long-term. It could be determined if bedtime procrastination had decreased, if distracting bedtime activities had decreased, and if screen-time near bedtime had dropped.

Ultimately, as Kroese et al. put it elegantly earlier, bedtime procrastination research is truly still in its infancy. There are many ways to further our collective knowledge in this domain, and in an ever-increasing technologically connected world of screens, social complexities, and nighttime activities it is crucial we place importance on proper sleep in individuals – especially early in the developmental stage of their life. Hopefully this research can be expanded upon to better create and design resources that enable and empower an individual to take agency on their sleeping habits and improve their life in whatever ways work best for them, to better achieve their own goals.

Chapter 6: Conclusion

This thesis explored how University students sleep at night – specifically their sleeping behavior surrounding bedtime procrastination – through exploratory analysis of their sleeping characteristics, reflections, and bedtime activities. While past work has indicated the dangers of insufficient sleep, this study has attempted to fill the gaps present regarding sleeping habits in students and their own perceptions and attitudes towards it. It contributes to the landscape of insufficient sleep in the context of bedtime procrastination, and at a crucial age level. Especially importantly, I conducted this study from a behavioral perspective, as the research present is not comprehensive. I found that the reasons and rationales for failing to sleep on time are more complex than just a student's life being "too busy" or staying up too late studying. Screen-time, bedtime distractors, and social expectations are just some of many factors that can lead to an individual delaying their bedtime. I determined that even though many students were previously unaware or uncaring towards their sleeping habits, and rationalized such habits in interesting ways, many wished to improve their sleep hygiene. Minimal self-tracking and reflection of one's sleep and context surrounding has the potential to provide better sleep, and consequently improvements in other aspects of their life.

Appendix A: Recruitment Text

Title: Understanding Bedtime Procrastination in University Students

The purpose of this research is to survey and interview University of Maryland students on their behavioral sleeping habits to determine reasons and rationalizations that lead to bedtime procrastination. The goal is to understand why students procrastinate their bedtimes and observe activities conducted near bedtime to determine which factors are responsible for bedtime procrastination.

This is a 2-week study - daily surveys will be completed over a period of 2 weeks for a total of 14 survey responses collected per participant. Each daily survey will take 5-10 minutes to complete. There will also be a 15-minute pre-study briefing and a 30-minute post-study interview.

Participants will receive:

- A $25 Amazon Gift Card
- Insight into their own sleeping behaviors and habits that may improve sleep quality

Location

- Entirely remote and online

Are you eligible?

- You must be a University of Maryland, College Park student (part time or full time)
- You must not have a medically diagnosed sleep disorder
- You must be 18+ years of age

If you're unsure if you meet the requirements, call or email a member of the study team:

- Matthew Patrick
- Principal Investigator
- mdp@umd.edu
- 443-987-8072

Appendix B: Qualtrics Daily Survey

UNIVERSITY OF MARYLAND

Participant ID:

Enter today's date:

← October 2021 →

Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	29	30	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

→

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What time did you wake up this morning? (X:XXam/pm)

→

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Is your wake time earlier than / later than / about the same as your intended wake time?

- ◯ Earlier (early wake-up)
- ◯ About the same (on-time)
- ◯ Later (slept-in)

When did you intend on sleeping last night? (X:XXpm/am)

What time did you actually start to sleep last night? (X:XXpm/am)

How do you feel about your sleep time last night?

→

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Please answer the following questions:

0 1 2 3 4 5 6 7 8 9 10

How well-rested would you rate yourself this morning? (0=very tired, 10=very well rested)

Please rate how satisfied you are with the quality of sleep you got last night. (0=very unsatisfied, 10=very satisfied)

Please rate how physically active you were the previous day. (0=almost no physical activity, 10=very physically active)

→

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Construct a list of all activities you participated in within 2 hours of sleeping last night. Please include approximate starting times, ending times, and activity details. Be as detailed as possible with the descriptions of each activity. For example, for “phone use” please include the device used and the applications used.

	Activity Name	Start Time (X:XXpm/am)	End Time (X:XXpm/am)	Activity Description (please copy and paste from separate text editor)	Technology Involved (hardware and software)	Rationale for doing activity at this time (if unsure, list "unsure")	Was this activity mandatory or self-imposed?	How important was doing this activity at this time? 0 (not very important) to 10 (very important)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

→

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When do you intend on sleeping this evening? (X:XXpm/am)

Please provide any other notes or irregularities that would be important for the researcher to know regarding this study for last night or today.

→

Appendix C: Post-Study Interview Questions

1. What is your current living environment?

   a) Who else are you living with?

   b) Do you share a room?

   c) Are you in an urban/suburban/rural area?

   d) In terms of noise/light/temperature/other environmental factors that might influence your sleep?

   e) Are you in a relationship?

2. What is your schedule like?

   a) School? Work? How would you characterize your school/work – whether that being high-stressful/low-stressful job?

   b) Any obligations? Working toward deadlines?

   c) Fixed schedule or sporadic?

   d) Nighttime / bedtime routine?

3. How have your sleeping habits and behaviors changed throughout your adolescence and young adulthood? Include any environmental changes such as living arrangements.

4. What do healthy sleeping habits mean to you?

5. How have you gained knowledge on sleep related health previously?

6. In what ways are sleeping habits important to you?

7. Why do you think you slept later than intended on certain days?

    a) When asking this question, prompt them with their own data (show them in a readable form / summarization)

8. Can you identify some specific reasons you delayed your bedtime?

9. Walk me through your though process for the nighttime activities on [date]. (ask about irregularities)

10. What impact has this study left on you in terms of your own sleeping behavior?

11. Is there anything else you would like to let the researcher know?

(add unique questions based on participant's data, especially if notable or irregular patterns or instances are present)

Bibliography

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77-101.

Cherubini, J. M., Cheng, J. L., Williams, J. S., & MacDonald, M. J. (2021). Sleep deprivation and endothelial function: reconciling seminal evidence with recent perspectives. American Journal of Physiology-Heart and Circulatory Physiology, 320(1), H29-H35.

Cho, H., Choi, D., Kim, D., Kang, W. J., Choe, E. K., & Lee, S. J. (2021). Reflect, not Regret: Understanding Regretful Smartphone Use with App Feature-Level Analysis. Proceedings of the ACM on Human-Computer Interaction, 5(CSCW2), 1-36.

Choe, E. K. (2014). Designing self-monitoring technology to promote data capture and reflection (Doctoral dissertation).

Choe, E. K., Lee, B., Kay, M., Pratt, W., & Kientz, J. A. (2015, September). SleepTight: low-burden, self-monitoring technology for capturing and reflecting on sleep behaviors. In Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing (pp. 121-132).

Choe, E. K., Lee, B., Zhu, H., Riche, N. H., & Baur, D. (2017, May). Understanding self-reflection: how people reflect on personal data through visual data exploration. In Proceedings of the 11th EAI International Conference on Pervasive Computing Technologies for Healthcare (pp. 173-182).

Choe, E. K., Lee, N. B., Lee, B., Pratt, W., & Kientz, J. A. (2014, April). Understanding quantified-selfers' practices in collecting and exploring personal data. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 1143-1152).

Cui, G., Yin, Y., Li, S., Chen, L., Liu, X., Tang, K., & Li, Y. (2021). Longitudinal relationships among problematic mobile phone use, bedtime procrastination, sleep quality and depressive symptoms in Chinese college students: a cross-lagged panel analysis. BMC psychiatry, 21(1), 1-12.

Exelmans, L., & Van den Bulck, J. (2021). “Glued to the Tube”: the interplay between self-control, evening television viewing, and bedtime procrastination. Communication Research, 48(4), 594-616.

File, T., & Ryan, C. (2014). Computer and internet use in the United States, 2013. US Department of Commerce, Economics and Statistics Administration, US Census Bureau.

Gallup (2013). In US 40% gets less than recommended amount of sleep. Available from www.gallup.com/poll/166553/less-recommended-amount-sleep.aspx

Grace, T. W. (1997). Health problems of college students.

Kamenetz, A. (2016). *How college students are sleeping ... or not*. NPR. Retrieved November 5, 2021, from https://www.npr.org/sections/ed/2016/05/02/475581810/how-college-students-are-sleeping-or-not.

Keng, S. L., Smoski, M. J., & Robins, C. J. (2011). Effects of mindfulness on psychological health: A review of empirical studies. Clinical psychology review, 31(6), 1041-1056.

Keulen, E. V. (2020). Why Would You Sleep? A Study on Awareness of Short-term and Long-term Health Consequences of Insufficient Sleep in association with Bedtime Procrastination, moderated by Chronotype (Master's thesis).

Kocielnik, R., Xiao, L., Avrahami, D., & Hsieh, G. (2018). Reflection Companion: a conversational system for engaging users in reflection on physical activity. Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 2(2), 1-26.

Kroese, F. M., Nauts, S., Kamphorst, B. A., Anderson, J. H., & de Ridder, D. T. (2016). Bedtime procrastination: a behavioral perspective on sleep insufficiency. In Procrastination, health, and well-being (pp. 93-119). Academic Press.

Leatherdale, S. T., & Ahmed, R. (2011). Screen-based sedentary behaviours among a nationally representative sample of youth: are Canadian kids couch potatoes. Chronic Dis Inj Can, 31(4), 141-146.

Ma, X., Meng, D., Zhu, L., Xu, H., Guo, J., Yang, L., ... & Mu, L. (2020). Bedtime procrastination predicts the prevalence and severity of poor sleep quality of Chinese undergraduate students. Journal of American College Health, 1-8.

Mark, G., Wang, Y. D. O. I., Niiya, M., & Reich, S. (2016, May). Sleep debt in student life: Online attention focus, Facebook, and mood. In Proceedings of the 2016 CHI conference on human factors in computing systems (pp. 5517-5528).

McDade, T. W., Chyu, L., Duncan, G. J., Hoyt, L. T., Doane, L. D., & Adam, E. K. (2011). Adolescents' expectations for the future predict health behaviors in early adulthood. Social science & medicine, 73(3), 391-398.

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle?. Psychological bulletin, 126(2), 247.

Nauts, S., Kroese, F. M., de Ridder, D. T. D., & Anderson, J. (2014). Reported reasons for and consequences of bedtime procrastination. Unpublished raw data.

Orzeł-Gryglewska, J. (2010). Consequences of sleep deprivation. International journal of occupational medicine and environmental health.

Perotta, B., Arantes-Costa, F. M., Enns, S. C., Figueiro-Filho, E. A., Paro, H., Santos, I. S., ... & Tempski, P. Z. (2021). Sleepiness, sleep deprivation, quality of life, mental symptoms and perception of academic environment in medical students. BMC Medical Education, 21(1), 1-13.

Pew Research Center. (2021). Demographics of internet and home broadband usage in the United States. Pew Research Center: Internet, Science & Tech. Retrieved November 5, 2021, from https://www.pewresearch.org/internet/fact-sheet/internet-broadband/.

Pilcher, J. J., & Huffcutt, A. I. (1996). Effects of sleep deprivation on performance: a meta-analysis. Sleep, 19(4), 318-326.

Ploderer, B., Reitberger, W., Oinas-Kukkonen, H., & van Gemert-Pijnen, J. (2014). Social interaction and reflection for behaviour change.

Short, M. A., Gradisar, M., Wright, H., Lack, L. C., Dohnt, H., & Carskadon, M. A. (2011). Time for bed: parent-set bedtimes associated with improved sleep and daytime functioning in adolescents. Sleep, 34(6), 797-800.

Sigman, A. (2012). Time for a view on screen time. Archives of disease in childhood, 97(11), 935-942.

Sorscher, A. J. (2008). How is your sleep: a neglected topic for health care screening. The Journal of the American Board of Family Medicine, 21(2), 141-148.